**What is claimed is:**

1. A method for transmitting signals in communications system having a transmitter with N transmit antennas transmitting over a forward channel to a receiver having L receiver antennas and a reverse channel for communicating from said receiver to said transmitter, in which there may exist correlation in the signals received by two or more of said L receive antennas, the method comprising the steps of:

determining the number of independent signals that can be transmitted from said N transmit antennas to said L receive antennas;

creating, from a data stream, a data substream to be transmitted for each of the number of independent signals that can be transmitted from said N transmit antennas to said L receive antennas;

weighting each of said substreams with N weights, one weight for each of said N transmit antennas, to produce N weighted substreams per substream;

combining one of said weighted substreams produced from each of said substreams for each of said transmit antennas to produce a transmit signal for each of said transmit antennas.

2. The invention as defined in claim 1 further comprising the step of transmitting said transmit signal from a respective one of said antennas.

3. The invention as defined in claim 1 further comprising the step of receiving said weights via said reverse channel.

4. The invention as defined in claim 1 wherein said weights are determined by said transmitter as a function of channel information and interference covariance received from said receiver via said reverse channel.

5. The invention as defined in claim 1 wherein said weights are determined by solving a matrix equation $H^{\dagger}(K^{N})H = U^{\dagger}\Lambda^{2}U$ where:

$H$ is a channel response matrix,

$H^{\dagger}$ is a conjugate transpose of said channel response matrix $H$,

$K^{N}$ is the interference covariance matrix,

$U$ is a unitary matrix, each column of which is an eigenvector of $H^{\dagger}(K^{N})H$,

$\Lambda$ is a diagonal matrix defined as $\Lambda = diag(\lambda^1,\ldots,\lambda^M)$, where $\lambda^1,\ldots,\lambda^M$ are each eignevalues of $H^\dagger(K^N)H$, M being the maximum number of nonzero eigenvalues, which corresponds to the number of said independent signals, and

$U^\dagger$ is the conjugate transpose of matrix U;

waterfilling said eigenvalues $\lambda$ by solving the simultaneous equations $\tilde{\lambda}^k = (\nu - \frac{1}{(\lambda^k)^2})^+$ and $\sum_k \tilde{\lambda}^k = P$, for $\nu$, where:

$k$ is an integer index that ranges from 1 to M,

$P$ is the transmitted power,

+ is an operator that returns zero (0) when its argument is negative, and returns the argument itself when it is positive, and

each $\tilde{\lambda}$ is an intermediate variable representative of a power for each weight vector;

defining matrix $\Phi$ as $\Phi = U^\dagger diag(\tilde{\lambda}^1,\ldots,\tilde{\lambda}^M)U$, where *diag* indicates that the various $\tilde{\lambda}$ are arranged as the elements of the main diagonal of matrix $\Phi$;

wherein each column of matrix $\Phi$ is used as a normalized weight vector indicated by $\Phi = [z_1,\ldots,z_N]$ and said normalized weight vectors are made up of individual normalized weights $z$, $z_i = [z_{i1},\ldots,z_{iN}]$, where $i$ is an integer ranging from 1 to N;

developing an unnormalized weight vector $w_i = [w_{i1},\ldots,w_{iN}]$, with each of said weights therein being $\sqrt{\tilde{\lambda}^i} z_{ij}$, where $j$ is an integer ranging from 1 to N.

6. Apparatus for transmitting signals in communications system having a transmitter with N transmit antennas transmitting over a forward channel to a receiver having L receiver antennas and a reverse channel for communicating from said receiver to said transmitter, in which there may exist correlation in the signals received by two or more of said L receive antennas, the apparatus comprising:

means for determining the number of independent signals that can be transmitted from said N transmit antennas to said L receive antennas;

means for creating, from a data stream, a data substream to be transmitted for each of the number of independent signals that can be transmitted from said N transmit antennas to said L receive antennas;

means for weighting each of said substreams with N weights, one weight for each of said N transmit antennas, to produce N weighted substreams per substream;

means for combining one of said weighted substreams produced from each of said substreams for each of said antennas to produce a transmit signal for each antenna.

7. The invention as defined in claim 6 wherein said transmitter comprises means for developing said weights.

8. The invention as defined in claim 6 wherein said transmitter comprises means for storing said weights.

9. The invention as defined in claim 6 wherein said receiver comprises means for developing said weights.

10. A transmitter for transmitting signals in communications system having a transmitter with N transmit antennas transmitting over a forward channel to a receiver having L receiver antennas and a reverse channel for communicating from said receiver to said transmitter, in which there may exist correlation in the signals received by two or more of said L receive antennas, the apparatus comprising:

a demultiplexor for creating, from a data stream, a data substream to be transmitted for each of the number of independent signals that can be transmitted from said N transmit antennas to said L receive antennas

multipliers for weighting each of said substreams with N weights, one weight for each of said N transmit antennas, to produce N weighted substreams per substream, each of said weights being a function of at least an estimate interference covariance matrix and an estimate of a forward matrix channel response between said transmitter and said receiver; and

adders for combining one of said weighted substreams produced from each of said substreams for each of said antennas to produce a transmit signal for each of said transmit antennas.

11. The invention as defined in claim 10 further comprising a digital to analog converter for converting each of said combined weighted substreams.

12. The invention as defined in claim 10 further comprising an upconverter for converting to radio frequencies each of said analog-converted combined weighted substreams.

13. The invention as defined in claim 10 wherein said weights are determined in said transmitter in response to said interference covariance matrix estimate and said estimate of the forward channel response received from said receiver over said reverse channel.

14. The invention as defined in claim 10 wherein said weights are determined in said receiver and are transmitted to said transmitter over said reverse channel.

15. The invention as defined in claim 10 wherein said weights are determined by solving a matrix equation $H^{\dagger}(K^{N})H = U^{\dagger}\Lambda^{2}U$ where:

H is a channel response matrix,

$H^{\dagger}$ is a conjugate transpose of said channel response matrix H,

$K^{N}$ is the interference covariance matrix,

U is a unitary matrix, each column of which is an eigenvector of $H^{\dagger}(K^{N})H$,

$\Lambda$ is a diagonal matrix defined as $\Lambda = diag(\lambda^{1},\ldots,\lambda^{M})$, where $\lambda^{1},\ldots,\lambda^{M}$ are each eignevalues of $H^{\dagger}(K^{N})H$, M being the maximum number of nonzero eigenvalues, which corresponds to the number of said independent signals, and

$U^{\dagger}$ is the conjugate transpose of matrix U;

waterfilling said eigenvalues $\lambda$ by solving the simultaneous equations $\tilde{\lambda}^{k} = (\nu - \frac{1}{(\lambda^{k})^{2}})^{+}$ and $\sum_{k} \tilde{\lambda}^{k} = P$, for $\nu$, where:

$k$ is an integer index that ranges from 1 to M,

$P$ is the transmitted power,

+ is an operator that returns zero (0) when its argument is negative, and returns the argument itself when it is positive, and

each $\tilde{\lambda}$ is an intermediate variable representative of a power for each weight vector;

defining matrix $\Phi$ as $\Phi = U^{\dagger}diag(\tilde{\lambda}^{1},\ldots,\tilde{\lambda}^{M})U$, where *diag* indicates that the various $\tilde{\lambda}$ are arranged as the elements of the main diagonal of matrix $\Phi$;

wherein each column of matrix $\Phi$ is used as a normalized weight vector indicated by $\Phi = [z_{1},\ldots,z_{N}]$ and said normalized weight vectors are made up of individual normalized weights $z$, $z_{i} = [z_{i1},\ldots,z_{iN}]$, where $i$ is an integer ranging from 1 to N;

developing unnormalized weight vector $w_{i} = [w_{i1},\ldots,w_{iN}]$, with each of said weights therein being $\sqrt{\tilde{\lambda}^{i}}\, z_{ij}$, where $j$ is an integer ranging from 1 to N.

16. The invention as defined in claim 10 wherein said transmitter and receiver communicate using time division multiplexing (TDD) and said weights are determined in said transmitter using an estimate of the forward channel response that is determined by a receiver of said reverse link for said transmitter.

17. A receiver for use in a MIMO system, comprising:

L antennas;

L downconverters;

an estimator for determining an estimate of an interference covariance matrix for a forward channel being received by said receiver; and

a transmitter for a reverse channel for transmitting said estimate of an interference covariance matrix to a receiver for said reverse channel.

18. A receiver for use in a MIMO system, comprising:

L antennas;

L downconverters;

an estimator for determining an estimate of an interference covariance matrix for a forward channel being received by said receiver;

an estimator for determining an estimate of a channel response for a forward channel being received by said receiver; and

a transmitter for a reverse channel for transmitting said estimate of an interference covariance matrix and said estimate of a channel response to a receiver for said reverse channel.

19. A receiver for use in a MIMO system, comprising:

an estimator for determining an estimate of an interference covariance matrix for a forward channel being received by said receiver;

an estimator for determining an estimate of a channel response for a forward channel being received by said receiver; and

a weight calculator for calculating weights for use by a transmitter of said forward channel to transmit data substreams to said receiver as a function of said estimate of an interference covariance matrix for a forward channel being received by said receiver and said estimate of a channel response for a forward channel being received by said receiver.

20. The invention as defined in claim 19 further including a transmitter for a reverse channel for transmitting said weights to a receiver for said reverse channel.

21. A receiver for use in a MIMO system, comprising:

L antennas;

L downconverters;

an estimator for determining an estimate of an interference covariance matrix for a forward channel being received by said receiver;

an estimator for determining an estimate of a channel response for a forward channel being received by said receiver; and

a weight calculator for calculating weights for use by a transmitter of said forward channel to transmit data substreams to said receiver, said weights being determined in said weight calculator by

solving a matrix equation $H^{\dagger}(K^{N})H = U^{\dagger}\Lambda^{2}U$ where:

H is a channel response matrix,

$H^{\dagger}$ is a conjugate transpose of said channel response matrix H,

$K^{N}$ is the interference covariance matrix,

U is a unitary matrix, each column of which is an eigenvector of $H^{\dagger}(K^{N})H$,

$\Lambda$ is a diagonal matrix defined as $\Lambda = diag(\lambda^{1},\ldots,\lambda^{M})$, where $\lambda^{1},\ldots,\lambda^{M}$ are each eignevalues of $H^{\dagger}(K^{N})H$, M being the maximum number of nonzero eigenvalues, which corresponds to the number of said independent signals, and

$U^{\dagger}$ is the conjugate transpose of matrix U;

waterfilling said eigenvalues $\lambda$ by solving the simultaneous equations $\tilde{\lambda}^{k} = (\nu - \frac{1}{(\lambda^{k})^{2}})^{+}$ and $\sum_{k} \tilde{\lambda}^{k} = P$, for $\nu$, where:

$k$ is an integer index that ranges from 1 to M,

$P$ is the transmitted power,

+ is an operator that returns zero (0) when its argument is negative, and returns the argument itself when it is positive, and

each $\tilde{\lambda}$ is an intermediate variable representative of a power for each weight vector;

defining matrix $\Phi$ as $\Phi = U^{\dagger}diag(\tilde{\lambda}^{1},\ldots,\tilde{\lambda}^{M})U$, where $diag$ indicates that the various $\tilde{\lambda}$ are arranged as the elements of the main diagonal of matrix $\Phi$;

wherein each column of matrix $\Phi$ is used as a normalized weight vector indicated by $\Phi = [z_{1},\ldots,z_{N}]$ and said normalized weight vectors are made up of individual normalized weights $z$, $z_{i} = [z_{i1},\ldots,z_{iN}]$, where $i$ is an integer ranging from 1 to N;

developing unnormalized weight vector $w_i = [w_{i1}, \ldots, w_{iN}]$, with each of said weights therein being $\sqrt{\tilde{\lambda}^i} z_{ij}$, where $j$ is an integer ranging from 1 to N.

22. A method for determining weights for use in transmitting signals in communications system having a transmitter with N transmit antennas transmitting over a forward channel to a receiver having L receiver antennas and a reverse channel for communicating from said receiver to said transmitter, in which there may exist correlation in the signals received by two or more of said L receive antennas, the method comprising the steps of:

determining the number of independent signals M that can be transmitted from said N transmit antennas to said L receive antennas through a process of determining weights for substreams derived from data to be transmitted via said N antennas as part of forming said signals, wherein said weights are determined by

solving a matrix equation $\mathrm{H}^\dagger(\mathrm{K}^{\mathrm{N}})\mathrm{H} = \mathrm{U}^\dagger \Lambda^2 \mathrm{U}$ where:

H is a channel response matrix,

$\mathrm{H}^\dagger$ is a conjugate transpose of said channel response matrix H,

$\mathrm{K}^{\mathrm{N}}$ is the interference covariance matrix,

U is a unitary matrix, each column of which is an eigenvector of $\mathrm{H}^\dagger(\mathrm{K}^{\mathrm{N}})\mathrm{H}$,

$\Lambda$ is a diagonal matrix defined as $\Lambda = diag(\lambda^1, \ldots, \lambda^{\mathrm{M}})$, where $\lambda^1, \ldots, \lambda^{\mathrm{M}}$ are each eigenvalues of $\mathrm{H}^\dagger(\mathrm{K}^{\mathrm{N}})\mathrm{H}$, M being the maximum number of nonzero eigenvalues, which corresponds to the number of said independent signals, and

$\mathrm{U}^\dagger$ is the conjugate transpose of matrix U;

waterfilling said eigenvalues $\lambda$ by solving the simultaneous equations $\tilde{\lambda}^k = (\nu - \frac{1}{(\lambda^k)^2})^+$ and $\sum_k \tilde{\lambda}^k = P$, for $\nu$, where:

$k$ is an integer index that ranges from 1 to M,

$P$ is the transmitted power,

+ is an operator that returns zero (0) when its argument is negative, and returns the argument itself when it is positive, and

each $\tilde{\lambda}$ is an intermediate variable representative of a power for each weight vector;

defining matrix $\Phi$ as $\Phi = \mathrm{U}^\dagger diag(\tilde{\lambda}^1, \ldots, \tilde{\lambda}^{\mathrm{M}})\mathrm{U}$, where $diag$ indicates that the various $\tilde{\lambda}$ are arranged as the elements of the main diagonal of matrix $\Phi$;

wherein each column of matrix $\Phi$ is used as a normalized weight vector indicated by $\Phi = [z_1, \ldots, z_N]$ and said normalized weight vectors are made up of individual normalized weights $z$, $z_i = [z_{i1}, \ldots, z_{iN}]$, where $i$ is an integer ranging from 1 to N;

developing unnormalized weight vector $w_i = [w_{i1}, \ldots, w_{iN}]$, with each of said weights therein being $\sqrt{\tilde{\lambda}^i}\, z_{ij}$, where $j$ is an integer ranging from 1 to N.